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STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

RUSSIAN RIVER SOCKEYE SALMON STUDY

by

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RESEARCH PROJECT SEGMENT

State: ALASKA Name: Sport Fish Investigations of Alaska

Project No.: AFS-44 Project Title: ANADROMOUS FISH STUDIES

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Cooperator: David C. Nelson

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ABSTRACT

A creel census was conducted during the Russian River sockeye salmon, Oncorhynchus nerka (Walbaum), sport fishery to determine harvest and effort. The census revealed 56,330 man-days of effort were expended to harvest 60,710 sockeye salmon. Early and late runs contributed 27,220 and 33,490 salmon, respectively, to this harvest. Harvest rate for the early run was 0.204 fish per angler-hour and 0.284 for the late run. The early run harvest rate is the highest recorded since 1966. Anglers harvested 34.4 percent of the sockeye salmon to return to the Russian River in 1980.

Escapements of early and late run sockeye salmon were determined by weir counts at the outlet of Lower Russian Lake. Early and late run escapements were 28,670 and 83,980 salmon, respectively. Escapements for both early and late runs exceeded the historical means by more than 100 percent. An additional 3,220 late run fish spawned below Russian River Falls. Total late run escapement was therefore 87,200 sockeye salmon. The total late run return (harvest plus escapement) in 1980 was 26.0 percent of the Kenai River escapement.

Analysis of scales collected at Lower Russian Lake weir revealed 81.0 percent of the early run were 6-year fish of Age class 2.3. Mean length of early run sockeye salmon was 591.5 millimeters. The male to female sex ratio was 1:0.9. Late run fish were primarily (56.6 percent) 5-year fish of Age class 2.2. Other age classes represented were: 1.2 (25.2 percent); 2.3 (10.8 percent); and 1.3 (7.4 percent). Mean length of late run fish sampled was 562.7 millimeters. Male to female sex ratio was 1:1.1.

Fecundity investigations revealed early and late run sockeye salmon averaged 3,534.3 and 2,739.7 eggs per female, respectively. Fecundities for

both runs were the lowest recorded since these investigations were initiated in 1973.

Water velocity through Russian River Falls was a total barrier to fish during all of the early and most of the late run migrations. One hundred percent of the early run and 85.5 percent of the late run utilized the fish pass to reach the Upper Russian Lake spawning grounds. Use and evaluation of this structure during the 1980 season is discussed.

Hydraulic egg sampling at Upper Russian Creek revealed early run egg deposition was 315.5 eggs per square meter. Egg survival was 68.6 percent at time of sampling. Observations suggest high water may have washed eggs from the gravel after sampling was conducted.

Climatological data were recorded at Lower Russian Lake Weir. Air and water temperatures approximated historical data, however, water discharge through Russian River Falls exceeded historic flow rates. Observation indicates these high flow rates were attributable to a heavy snowpack in the Russian River drainage and annual spring rains. The affect of high discharge rates on the migrational timing of early and late runs is presented and discussed.

BACKGROUND

Russian River is a clear stream adjacent to the Sterling Highway 9.6 km (6 mi) west of the Kenai Peninsula community of Cooper Landing and approximately 161 km (100 mi) south of Alaska's largest city, Anchorage. The stream is bordered by federally controlled lands. To the south, land is administered by the Kenai National Moose Range, and on the north by the Chugach National Forest. A privately operated ferry at the confluence of the Kenai and Russian River transports anglers to the south bank. This area (approximately 1.6 km or 1 mi) in an average year receives 50% of all angler effort as fishermen attempt to intercept the runs prior to their entry into Russian River. The remaining effort occurs on approximately 3.2 km (2 mi) of Russian River above the confluence area and below Russian River Falls. Public access is provided at the Kenai National Moose Range campground at the confluence of the Kenai and Russian Rivers and at the Chugach National Forest campground on the Russian River. Figure 1 depicts the general location of Russian River and the Russian River drainage in relation to the Kenai River and other pertinent land marks.

Sockeye salmon sport fishing is restricted to Lower Russian River from a marker 548 m (600 yd) below Russian River Falls to a marker 1,646 m (1,800 yd) below the confluence of Kenai and Russian Rivers, a total distance of approximately 4.8 km (3 mi). This area is commonly known as the "fly-fishing-only" area, and from June 1 through August 20 terminal gear is restricted to coho (streamer) flies with a gap between point and shank no greater than 9.5 mm (3/8 in). The area between a marker below the ferry crossing and a marker 640 m (700 yds) upstream on Russian River is closed to all fishing from June 1 through July 14 to provide additional protection

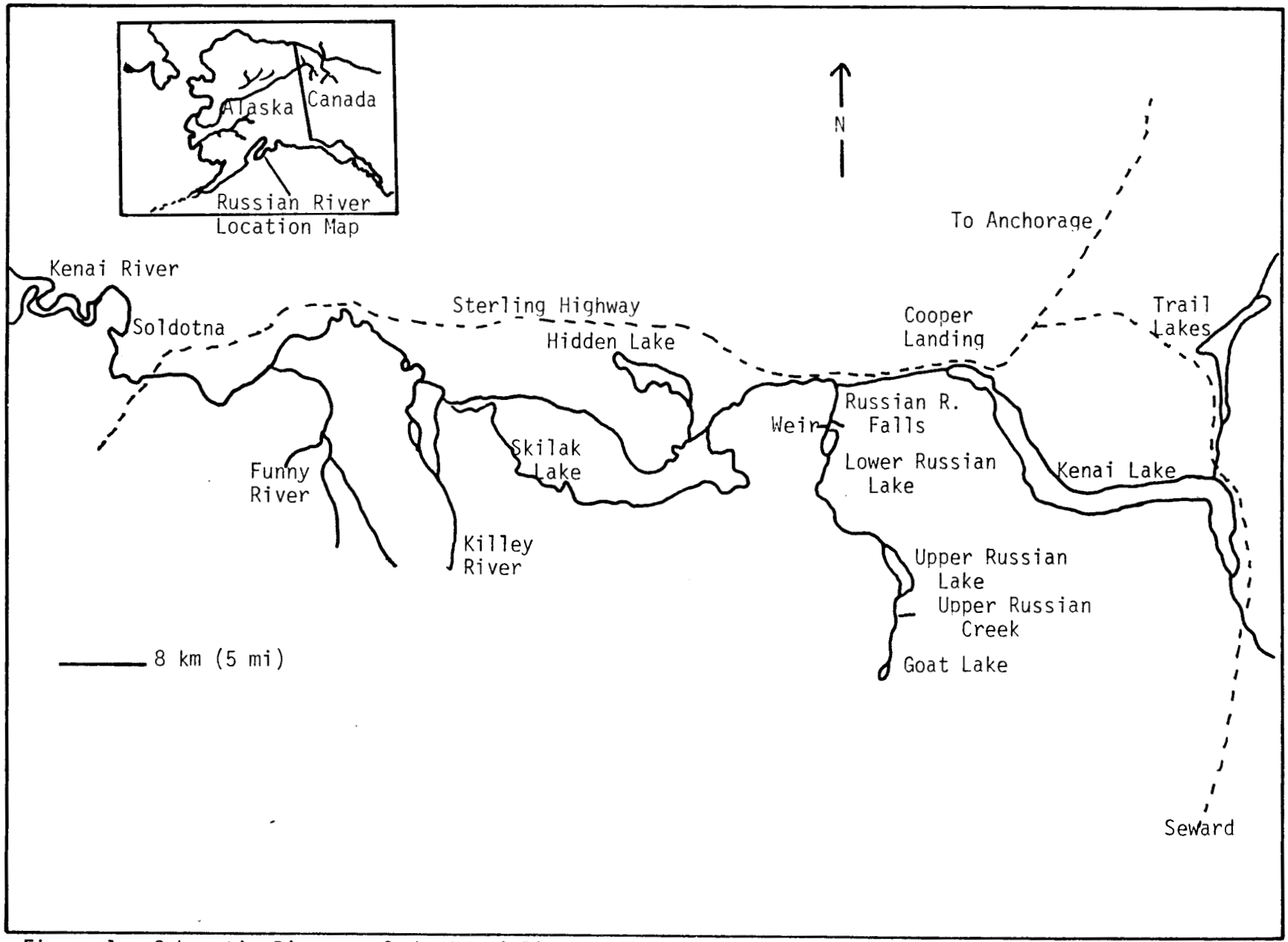

Figure 1. Schematic Diagram of the Kenai River Drainage.

to early run sockeye salmon which concentrate in this area for a period of time before continuing their upstream migration (Figure 2). Sockeye salmon sport fishing is permitted in the Kenai River below the "fly-fishing-only" area with conventional tackle. Harvest and effort here is minimal due to the glacial nature of the Kenai River.

Lower Russian River from its confluence with the Kenai River upstream approximately 3.2 km (2 mi) is of moderate gradient. Above this point the stream flows through a canyon of considerable gradient known as Russian River Falls. Sockeye salmon migrations have been delayed and/or totally blocked in the canyon on several occasions due to a velocity barrier caused by atypically high water. Documented mortalities of both early and late run sockeye salmon were associated with this barrier in 1971 and 1977 (Nelson, 1978). In 1979 a fish pass was constructed around the Falls to enable salmon to negotiate the barrier at all water levels.

Russian River sockeye salmon runs are bimodal; i.e., there are two distinct runs. Early and late runs have averaged 22,200 and 51,290 fish, respectively, from 1963 through 1979. Migrational timing and entry into the fishery for these stocks has been previously discussed (Nelson, 1976 and 1977). Resident and anadromous fish species common to Russian River are presented in Table 1.

Lower Russian Lake, located 0.8 km (0.5 mi) above Russian River Falls, supports an active Dolly Varden and rainbow trout sport fishery. Physical characteristics of the lake have been previously described (Nelson, 1979). Sockeye salmon spawning in this lake is confined to less than 500 late run fish (Nelson, 1979). Observation indicates this lake is utilized by rearing chinook and coho salmon.

Upper Russian River enters Lower Russian Lake from the south. This stream connects Upper and Lower Russian Lakes. Nelson (1976) has presented a detailed description of this stream and the Upper Russian Lake drainage. Figure 3 is a schematic diagram of Upper Russian Lake delineating the spawning areas of both early and late runs.

Management and research associated with the Russian River sockeye salmon sport fishery has been conducted by the Sport Fish Division of the Alaska Department of Fish and Game since 1962. Prior information pertaining to this fishery has been presented by Lawler (1963, 1964) Engel (1965 through 1972) and Nelson (1973 through 1980).

Despite an increasingly restrictive fishery, recreational demands upon the Russian River sockeye salmon resource has at times been greater than the stocks could sustain. This is evidenced in that the Sport Fish Division has closed all or part of the fishery on 17 different occasions since 1969. Extensive emergency openings and closings of this system indicate that it is the most intensely managed sport fishery in Alaska.

The Russian River program is currently directed towards, "in season" evaluation of stock status to determine the effects and effectiveness of current

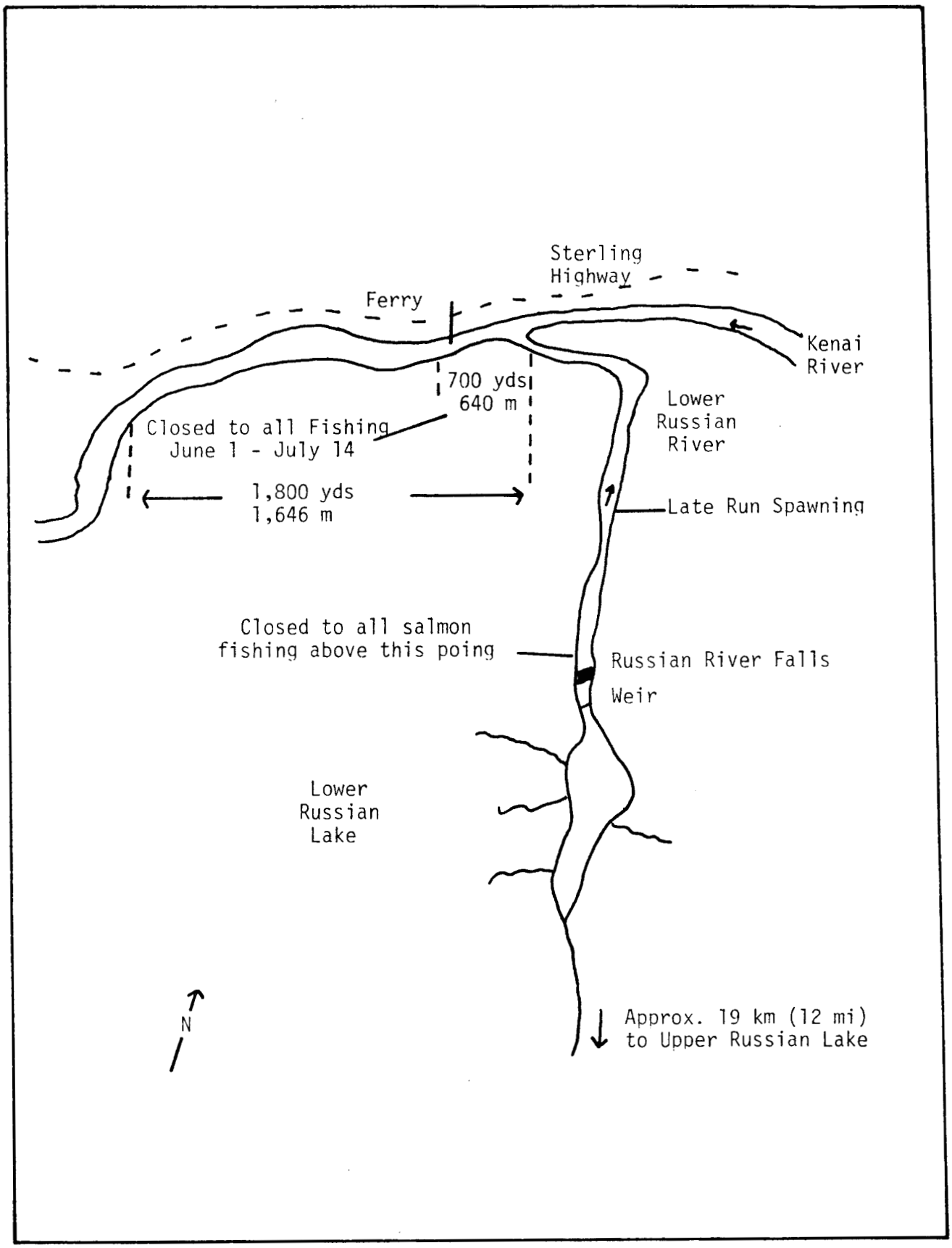

Figure 2. Schematic Diagram of Lower Russian River and Kenai and Russian River Confluence (Not To Scale).

Table 1. A List of Common Names, Scientific Names and Abbreviations of Fish Species Found in Russian River Drainage.

Common Name	Scientific Name and Author	Abbreviation
Sockeye salmon	Oncorhynchus nerka (Walbaum)	RS
Chinook salmon	Oncorhynchus tshawytscha (Walbaum)	KS
Coho salmon	Oncorhynchus kisutch (Walbaum)	SS
Pink salmon	Oncorhynchus gorbuscha (Walbaum)	PS
Dolly Varden	Salvelinus malma (Walbaum)	DV
Rainbow trout	Salmo gairdneri Richardson	RT
Slimy sculpin	Cottus cognatus Richardson	SSC

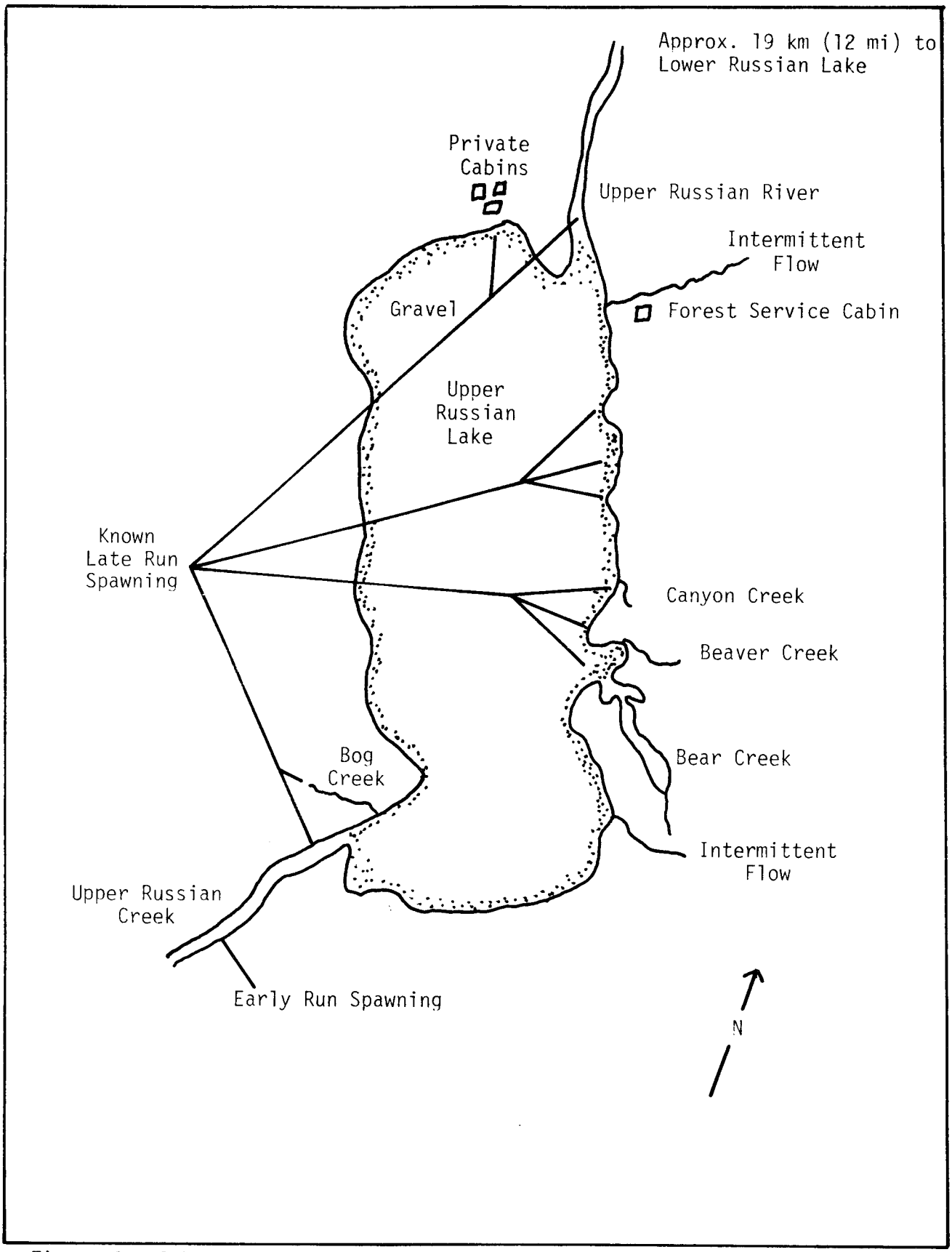

Figure 3. Schematic Diagram of Upper Russian Lake (Not To Scale).

regulatory practices. Research activities emphasize the collection and evaluation of life history data. Objectives include determination of optimum escapement goals for both runs and ultimately predictions of sockeye salmon returns to Russian River. The latter objective can not be realized until stock separation techniques are perfected in Cook Inlet to determine the late run Russian River sockeye salmon's contribution to the commercial fishery.

RECOMMENDATIONS

1. The feasibility of stabilizing the flow of Upper Russian Creek during the early run's spawning and egg incubation periods should be investigated. Data and observation indicate eggs were washed from the gravel by high water in 1976, 1977, 1979 and 1980. Egg loss from high water will adversely affect the number of returning adults.

2. Management options associated with the operation of the Russian River fish pass should continue to be investigated.

3. Continue the present objectives of the Russian River sockeye salmon study.

OBJECTIVES

1. To determine adult harvest of sport-caught early and late run Russian River sockeye salmon in the Russian River drainage.

2. To collect and analyze biological data concerning abundance and migrational timing of adult sockeye salmon in the Russian River drainage.

3. To determine age composition of adult early and late run Russian River sockeye salmon escapements enumerated at Lower Russian Lake weir.

4. To determine egg deposition of early run spawning sockeye salmon in Upper Russian Creek.

5. To determine the fecundity of early and late run female sockeye salmon and the relationship between fish length and average number of eggs per sockeye salmon female.

6. To collect basic climatological data (precipitation, water and air temperature, stream discharge) at Lower Russian Lake and to determine if a relationship exists between the parameters and migrational timing.

7. To evaluate the effects and effectiveness of a fish pass at Russian River Falls.

8. To evaluate current regulations governing this sport fishery and to provide recommendations for future management and research.

TECHNIQUES USED

The 1980 Russian River creel census was a modification of the technique described by Neuhold and Lu (1957). Sampling procedures and data analysis were identical to those outlined by Engel (1965, 1970, 1972) and Nelson (1973, 1975).

Adult escapements were enumerated by weir at the outlet of Lower Russian Lake. The present weir was constructed in June 1975 and replaced a temporary weir (described by Engel, 1970) which had been employed since 1969. Nelson (1976) has presented a detailed description of the present structure.

In 1979 a fish pass was constructed at Russian River Falls. Nelson (1980) described the structure. Use of the fish pass by sockeye salmon was determined during the 1980 season. The early run was monitored from June 16 through July 2 and the late run during the peak of this stock's migration (July 23-July 29). Sockeye salmon migrating through the fish pass were counted with a tally counter at the upstream exit of the structure as they passed over a white plywood board. Fifteen minute counting periods were randomly selected. The counting day was from 0300 to 2300 hours. Use of the fish pass from 2400 to 0300 hours was assumed to be minimal based on low counts during late evening and early morning hours. Seventy seven counts were made during the early run. The mean value of these counts was increased by four to determine the mean hourly passage rate. This figure was then multiplied by the total number of hours during the early run migration to determine the total number of early run sockeye salmon utilizing the fish pass. Similar calculations were employed to estimate the late run's use of the structure.

Fecundity of early and late run sockeye salmon was determined by sampling at Lower Russian Lake weir. Sampling technique and data analysis has been described (Nelson, 1979).

Scale samples to determine the age structure of the respective runs were collected at Lower Russian Lake weir. Age designation, numbers of fish sampled, methods employed to determine the adult age structure and male to female sex ratio have been presented (Nelson, 1978).

Water and air temperature at Lower Russian Lake Weir were determined by Taylor maximum-minimum thermometer. Precipitation was determined by a gauge of standard manufacture. Stream velocity was determined by "Head Rod" Method as described by Nelson (1977).

FINDINGS

Creel Census

A creel census conducted from June 13 through August 18 on Russian River revealed anglers expended 56,330 man-days of effort or 247,950 angler-hours during the 1980 sockeye salmon fishery. Effort directed toward early and late run stocks was estimated at 31,430 and 24,900 man-days, respectively.

Based on interviews with 4,270 anglers who reported harvesting 4,600 sockeye salmon, total catch was estimated at 60,710 fish. Early and late runs contributed 27,220 and 33,490 salmon, respectively, to this harvest.

Mean hourly catch rates were higher on weekdays (0.270) than on weekends (0.210) due to greater congestion on weekends which reduced individual angler efficiency. Seasonal catch per hour was 0.243. This catch rate is the highest recorded at Russian River since 1965. Historical harvest, effort and catch per hour estimates are summarized in Table 2.

Total weekday and weekend day stream counts during the 1980 fishery averaged 299.1 and 317.8 anglers, respectively. When compared to historic data these counts indicate numbers of anglers at Russian River approached record levels. The high hourly angler count was on Saturday, July 26 at 0800 hours when 786 anglers were enumerated in the "fly-fishing-only" area of the Russian and Kenai Rivers.

Anglers fished an average of 4.2 hours on weekdays and 4.7 hours on weekends. These data represent a decrease in the number of hours fished per day when compared to historical data (Table 3). Although the reason(s) for the decreased time the angler spent on the stream is not known, it may be related to run size (Nelson, 1979). Large returns of Russian River sockeye salmon occurred in 1972, 1977 and 1978 through 1980. Average hours fished per angler per day during these years of high returns were less than the historical average.

Stream counts revealed 51.8 and 40.1% of the anglers fished the confluence of the Kenai and Russian Rivers during the early and late run, respectively. The early run was one of the largest recorded at Russian River. Catch per hour data indicated excellent fishing in all sections of the "fly-fishing-only" area. This is the probable reason for an equal division of effort between the clear waters of the Russian River and the confluence of the Kenai and Russian Rivers. The late run was the largest recorded at Russian River and the migrational rate of these fish was temporarily slowed by Russian River Falls. Late run fish therefore "held" for a period of time in the Russian River where they were vulnerable to capture by sport fishermen. Large numbers of readily harvestable salmon in Russian River therefore account for the increased emphasis on this section of stream during the late run sockeye salmon fishery.

Anglers harvested 48.7% of the early run stocks to return to Russian River and 27.7% of the late. These exploitation rates are relatively low in

Table 2. Estimated Sockeye Salmon Harvest, Effort and Success Rates on Russian River, 1963-1980.

Year	Harvest			Total Effort (Man-Days)	Catch/ Hour	Census Period
	Early Run	Late Run	Total			
1963	3,670	1,390	5,060	7,880	0.190	6/08-8/15
1964	3,550	2,450	6,000	5,330	0.321	6/08-8/16
1965	10,030	2,160	12,190	9,720	0.265	6/15-8/15
1966	14,950	7,290	22,240	18,280	0.242	6/15-8/15
1967	7,240	5,720	12,960	16,960	0.141	6/10-8/15
1968	6,920	5,820	12,740	17,280	0.134	6/10-8/15
1969	5,870	1,150	7,020	14,930	0.094	6/07-8/15
1970	5,750	600	6,350	10,700	0.124	6/11-8/15*
1971	2,810	10,730	13,540	15,120	0.192	6/17-8/30*
1972	5,040	16,050	21,090	25,700	0.195	6/17-8/21
1973	6,740	8,930	15,670	30,690	0.102	6/08-8/19*
1974	6,440	8,500	14,940	21,120	0.131	6/08-7/30*
1975	1,400	8,390	9,790	16,510	0.140	6/14-8/13*
1976	3,380	13,700	17,080	26,310	0.163	6/12-8/23*
1977	20,400	27,440	47,840	69,510	0.168	6/18-8/17
1978	37,720	24,530	62,250	69,860	0.203	6/07-8/09
1979	8,400	26,830	35,230	55,000	0.136	6/09-8/20*
1980	27,220	33,490	60,710	56,330	0.243	6/13-8/20
1963-79 Mean	8,842	10,099	18,941	25,347	0.173	

* Census period was not continuous during these years due to emergency closures required to increase escapement levels.

Table 3. Differences Between Weekday and Weekend Day Fishing Pressure and Rates of Success at Russian River, 1964-1980.

Year	Mean Angler Counts		Catch/Hour		Mean Hours Fished	
	Week-days	Weekend Days	Week-days	Weekend Days	Week-days	Weekend Days
1964	29.6	70.6	0.444	0.209	3.3	3.9
1965	31.7	78.1	0.305	0.223	4.5	5.4
1966	53.2	143.1	0.297	0.183	4.8	5.5
1967	68.9	110.5	0.171	0.100	5.3	5.4
1968	71.5	124.9	0.153	0.107	5.3	5.8
1969	64.5	111.7	0.110	0.074	4.9	5.1
1970	83.5	127.8	0.140	0.100	4.8	4.7
1971	87.9	157.2	0.194	0.189	4.8	5.3
1972	73.3	138.5	0.203	0.187	4.0	4.4
1973	147.1	195.0	0.113	0.088	4.8	5.5
1974	123.8	144.4	0.164	0.085	4.7	5.7
1975	65.0	149.6	0.145	0.136	4.5	5.1
1976	72.5	134.4	0.165	0.161	3.5	4.5
1977	201.7	438.6	0.172	0.164	3.9	4.3
1978	264.1	425.7	0.205	0.191	3.9	4.2
1979	190.6	276.8	0.158	0.117	3.8	3.9
1980	299.1	317.8	0.270	0.210	4.2	4.7
1964-79 Mean	101.8	176.7	0.196	0.145	4.4	4.9

relation to the high numbers of returning early and late run fish. Angler opportunity was increased during the early run when the "sanctuary" area at the confluence of the Kenai and Russian Rivers was opened on June 19. On June 20 the restrictive early run bag and possession limit of one fish was increased to three. Had these liberalizations not occurred the early run exploitation rate would have been lower.

The low percentage of late run fish caught is directly attributable to the speed of the late run's migration through the fishery. Late run fish did not arrive in harvestable numbers until July 20. Catch rates remained high until August 5 and rapidly declined thereafter. Late run fish were therefore available in large numbers for approximately 17 days. In an average year these fish are present in harvestable numbers until the close of the season on August 20.

High water forced the majority of the late run fish to circumvent Russian River Falls via the fish pass. By July 26 the minimum late run escapement through Lower Russian Lake Weir was achieved and attempts were made to slow the rapid migrational rate through closure of the fish pass. It was reopened July 29 for 24 hours and closed again July 30. Alternating opening and closing of the structure continued until August 5. A continuous closure of the structure was not employed to preclude placing undue stress on salmon which had passed through the fishery and were at the base of the Falls. On August 5 discharge rates in Russian River decreased and the remaining late run sockeye salmon readily negotiated the Falls. Observation suggests that employing the fish pass in the manner described increased angler harvest by approximately 5,000 fish.

Nelson (1976) reviewed angler participation trends and suggested angler effort would continue to shift from the smaller early run to the more numerous late run stocks. Table 4 indicates these trends did not develop, as from 1977 through 1980, 57.9% of all angler effort was directed toward early run sockeye salmon. The average early run total return (harvest + escapement) during these years was 48,082, or more than twice the historical average return of 22,200. It is therefore evident that angler effort in a given year will generally be directed towards the most numerous stock which is more readily exploited than toward the early or late run, per se (Nelson, 1980).

During the creel census 37 Dolly Varden, 11 rainbow trout and 1 coho salmon were creel checked. Data were expanded to reveal a harvest of 590 Dolly Varden and 180 rainbow trout. No estimate for coho salmon was made as these fish were not available in harvestable numbers until after the termination of the creel census on August 18. No other incidentally caught species were reported during the 1980 season.

Escapement

The weir at the outlet of Lower Russian Lake was operational June 12. The first early run sockeye salmon was passed on June 14, three days prior to the historical arrival date of June 17. Fifty percent of the run had passed the weir by June 29. Early run passage was complete by July 20 (Table 5).

Table 4. Angler Effort Directed Toward Early and Late Run Russian River Sockeye Salmon Stocks, 1963-1980.

Year	Effort (Man-Days)*		Effort (Percent)	
	Early Run	Late Run	Early Run	Late Run
1963	5,710	2,170	72.5	27.5
1964	3,980	1,350	74.7	25.3
1965	7,750	1,970	79.7	20.3
1966	11,970	6,310	65.5	34.5
1967	11,460	5,500	67.6	32.4
1968	11,780	5,500	68.2	31.8
1969	12,290	2,640	82.3	17.7
1970	9,700	1,000	90.7	9.3
1971	6,250	8,870	41.3	58.7
1972	12,340	13,360	48.0	52.0
1973	15,220	15,470	49.6	50.4
1974	11,090	10,030	52.5	47.5
1975	5,210	11,300	31.5	68.5
1976	8,930	17,380	33.9	66.1
1977	38,200	31,310	55.0	45.0
1978	51,910	17,950	74.3	25.7
1979	25,670	29,330	46.7	53.3
1980	31,430	24,900	55.8	44.2
1963-79 Mean	14,674	10,673	60.8	39.2

* Man-day is defined as one angler fishing for one day irrespective of the number of hours fished.

Table 5. Arrival Date, Dates Fifty Percent of the Escapement Passed Russian River Weir/Counting Tower and Termination Dates of Early and Late Russian River Sockeye Salmon Runs, 1960-1980*.

	Early Run			Late Run		
Year	Arrival At Weir/ Counting Tower	Date 50% Passed	Date Run Ended	Arrival At Weir/ Counting Tower	Date 50% Passed	Date Run Ended**
1960	June 19	June 26	July 15	July 16	August 1	August 12
1961	June 21	June 28	July 15	July 16	July 31	August 28
1962	June 18	July 4	July 15	July 16	July 30	August 31
1963	June 18	July 1	July 12	July 16	July 31	August 23
1964	June 20	July 7	July 15	July 16	July 30	August 15
1965	June 22	July 4	July 15	July 16	August 5	August 15
1966	June 20	June 29	July 15	July 19	July 30	August 17
1967	June 20	June 28	July 15	July 19	August 2	August 18
1968	June 25	June 29	July 13	July 19	July 31	August 14
1969	NO DATA AVAILABLE			July 16	August 2	August 18
1970	June 17	July 5	July 15	July 16	August 7	August 23
1972	June 24	July 5	July 29	July 30	August 5	August 28
1973	June 21	July 6	July 15	July 16	August 1	August 30
1974	June 14	July 1	July 21	July 22	August 7	August 27
1975	June 25	July 6	July 27	July 21	August 6	September 1
1976	June 17	June 30	July 16	July 17	August 2	September 1
1978	June 10	July 2	July 24	July 2	July 30	September 1
1979	June 8	June 27	July 15	July 16	July 29	September 2
1980	June 14	June 29	July 20	July 21	July 30	September 6
1960-79 Mean	June 19	July 2	July 17	July 16	August 2	August 24
1969-79*** Mean	June 17	July 3	July 20	July 17	August 3	August 28

* 1971 and 1977 data were deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Date run ended and/or counting tower or weir count terminated.

*** Years of weir operation.

Early run escapement was 28,670 fish. This is one of the largest early run escapements recorded, exceeding the historical mean (1963-1979) escapement of 13,368 by 114.5%. The 1980 escapement was exceeded only by the record early run escapement in 1978 (34,150). This is the fifth consecutive year in which early run escapements have exceeded the minimum escapement goal of 9,000 fish (Table 6).

Late run fish arrived at the weir July 21. Fifty percent of the spawning escapement had passed the structure by July 30. Late run migration was complete on September 6 when the weir was removed. Escapement of late run sockeye salmon above Russian River Falls was 83,980. This is the second largest escapement recorded for this segment of the population exceeding the historical mean (1963-1979) escapement of 41,195 by 103.9%. The previous high escapement was 87,920 in 1979. An additional 3,220 late run fish spawned below Russian River Falls. Total late run escapement in 1980 was therefore 87,200. Total late run return (harvest + escapement) was a record 120,690. Late run escapements and total return to Russian River are presented in Table 7.

The chinook salmon escapement in 1980 enumerated at Russian River weir was 185. An additional 65 fish of this species spawned below Russian River Falls. The total chinook salmon escapement of 250 closely approximates the historical mean escapement of 251. Coho salmon escapement was 3,189. This is the seventh consecutive year the escapement of this species has exceeded the historical mean escapement (Table 8).

Relationship of Jacks To Adults

Jack (precocial male) sockeye salmon are generally not associated with the early sockeye salmon run. Historical data indicate jacks have been observed in the early run during only 5 of 11 years of weir operation. Jacks are more numerous during the late run comprising 0.2 to 8.8% of the escapement (Table 9).

As suggested by Nelson (1977) a relationship may exist between numbers of jacks in the late run escapement and the magnitude of the return the following year. The mean number of jacks returning in 1969, 1972, 1973 and 1977 was only 345. The mean total return (harvest + escapement) in succeeding years was 38,653, or 7.0% below the 1968-1980 mean return of 41,371. Jack return for 1970-1971, 1974-1975, 1976 and 1978-1979 averaged 1,760. The average return in succeeding years was 75,327. A relatively small jack escapement in a given year may therefore indicate a less than average return the following year. The converse may also be true.

Although a relationship does appear to exist between the number of jacks and the total late run return the succeeding year, predictions regarding future run strength cannot be predicated on this relationship. Jacks are not harvested by the Cook Inlet commercial fishery. Mesh size employed is too large to capture these fish. The percentage of the late Russian River run harvested by the commercial fishery is not known, nor is it known if this percentage is constant. If a high percentage of Russian River sockeye

Table 6. Russian River Sockeye Salmon Escapement Estimates and Harvest Rates for Early and Late Runs, 1963-1980.

Year	Escapement*			Percentage of Run Caught by the Sport Fishery		
	Early Run	Late Run	Total	Early Run	Late Run	Combined
1963	14,380	51,120	65,500	20.3	2.0	7.2
1964	12,700	46,930	59,630	21.8	5.0	9.6
1965	21,710	21,820	43,330	31.8	9.0	21.6
1966	16,660	34,430	51,090	47.3	17.5	30.3
1967	13,710	49,480	63,190	34.6	10.3	17.0
1968	9,200	48,880	58,080	42.9	10.6	18.0
1969	5,000**	28,920	33,920	54.0	3.8	17.1
1970	5,450	28,200	33,650	51.3	2.1	15.9
1971	2,650	54,430	57,080	51.5	16.4	19.2
1972	9,270	79,000	88,270	35.2	16.8	19.3
1973	13,120	24,970	38,090	33.9	26.3	29.1
1974	13,150	24,650	37,800	32.9	25.6	28.3
1975	5,640	31,970	37,610	19.9	20.8	20.7
1976	14,700	31,950	46,650	18.7	30.0	26.8
1977	16,070	21,410	37,480	55.9	56.2	56.1
1978	34,150	34,230	68,380	52.5	41.7	47.7
1979	19,700	87,920	107,620	29.9	23.4	24.7
1980	28,670	83,980	112,650	48.7	29.7	35.0
1963-79 Mean	13,368	41,195	54,551	37.3	18.7	24.0

* Escapement passed weir. Commercial harvest and fish spawning downstream from Russian River weir are deleted.

** Escapement determined by foot survey of Upper Russian Creek.

Table 7. Late Run Russian River Sockeye Salmon Total Return and Escapement Enumerated above and below Russian River Falls, 1968-1980.

Year	Escapement Above Falls	Escapement Below Falls	Total Escapement	Percent of Escapement Below Falls	Sport Harvest	Total Return
1968	48,800	4,200	53;000	7.9	5,820	58,820
1969	28,920	1,100	30,020	3.7	1,150	31,170
1970	28,200	220	28,420	0.8	600	29,020
1971	54,430	10,000	64,430	15.5	10,730	75,160
1972	79,000	6,000	85,000	7.1	16,050	101,050
1973	24,970	6,690	31,660	21.1	8,930	40,590
1974	24,650	2,210	26,860	8.2	8,500	35,360
1975	31,970	690	32,660	2.1	8,390	41,050
1976	31,950	3,470	35,420	9.8	13,700	49,120
1977	21,410	17,090	38,500	44.4	27,440	65,940
1978	34,230	18,330	52,560	34.9	24,530	77,090
1979	87,920	3,920	91,840	4.3	26,830	118,670
1980	83,980	3,220	87,200	4.0	33,490	120,690
1968-1979 Mean	41,371	6,160	47,531	13.3	12,723	60,253

Table 8. Coho and Chinook Salmon Escapements in the Russian River Drainage, 1953-1980.

Year	Weir/Counting Tower Escapement		Lower River	Total Escapement	
	Chinook	Coho	Chinook Escapement*	Chinook	Coho
1953			85**		
1954			87**		
1955			42**		
1956			40**		
1957			44**		
1958			98**		
1966			182		
1967			126		
1968	56		63	119	
1969	119	70	31	150	70
1970	240	957	125	365	957
1971	21	839	149	170	839
1972	172	666	108	280	666
1973	243	200	104	347	200
1974	124	1,508	59	183	1,508
1975	102	4,000	32	134	4,000
1976	145	1,791	155	300	1,791
1977	37	1,884	145	182	1,884
1978	253	1,570	165	418	1,570
1979	280	2,400	82	362	2,400
1980	185	3,189	65	250	3,189
Mean through 1979	149	1,444	96	251	1,353

* Coho salmon do not spawn in Lower Russian River.

** Fish and Wildlife Service Surveys.

Table 9. Late Run Russian River Sockeye Salmon Harvest, Escapement and Returning Jacks, 1969-1980.

Year	Escapement	Harvest	Total Return*	Number of Jacks	Percent of Total Return
1969	28,920	1,150	30,070	352	1.2
1970	28,200	600	28,800	2,542	8.8
1971	54,430	10,730	65,160**	1,429	2.2
1972	79,000	16,050	95,050	160	0.2
1973	24,970	8,930	33,900	332	1.0
1974	24,650	8,500	33,150	1,008	3.0
1975	31,970	8,390	40,360	1,788	4.4
1976	31,950	13,700	45,650	1,204	2.6
1977	21,410	27,440	48,850	537	1.1
1978	34,230	24,530	58,760	2,874	4.9
1979	87,920	26,830	114,750	1,476	1.3
1980	83,980	33,490	117,470	1,533	1.3
1969-79 Mean	40,695	13,350	54,045	1,246	2.8

* Excluded commercial harvest and late run sockeye salmon spawning below Russian River Falls.

** Excludes an estimated 10,000 late run sockeye salmon which perished below Russian River Falls due to a velocity barrier.

salmon is commercially harvested, the return of this stock to Russian River may be relatively low irrespective of the preceding years' jack escapement. The converse may also occur. Definitive conclusions regarding the relationship of jacks and the succeeding year's return to Russian River must therefore be deferred until this stock's contribution to the commercial fishery can be positively ascertained.

Table 10 compares the migrational timing of jacks to late run adult sockeye salmon. Historical data indicate 50% of the adult escapement may be expected to pass the weir by August 3, while 50% of the jack escapement is not enumerated until August 13, 9 days later than the adults. In 1980 the disparity in migrational timing between jacks and adults was 20 days.

This timing differential may be a genetic trait, related to environmental factors or a combination thereof. Nelson (1976) indicated water levels generally decrease during the latter part of the late run's migration and may facilitate the jacks' migration through the Falls. Larger adults may be more readily capable of ascending the Falls at greater water velocities and therefore arrive earlier at the weir. Russian River velocities were atypically high during the 1980 late run migration and, despite the presence of the fish pass, smaller jacks may have experienced difficulty ascending and/or circumventing the barrier. This may account for the 20-day disparity in 1980 passage rates between jacks and adults rather than the historical 9-day difference.

Migrational Rates in the Kenai River

Migrational rates of Russian River stocks within the mainstem Kenai River are limited to isolated tagging studies and a comparison of sonar counts to escapements at Russian River weir. Nelson (1977) has reviewed results of the tagging studies.

The sonar counter, located approximately 1.6 km (1 mi) below the Kenai River bridge in Soldotna is operated by the Commercial Fish Division of the Alaska Department of Fish and Game. The counter is usually operational only during the late run, but was used in 1978 and 1979 to enumerate the early Kenai River sockeye salmon run. Available data indicate the majority of the early run are of Russian River origin.

Nelson (1979) reported that in 1978 and 1979 it required early run fish 29 and 20 days, respectively, to traverse the 93.5 km (58 mi) between sonar site and weir. The migrational rate therefore ranged from 3.2 km (2 mi) to 4.6 km (2.9 mi) per day. The sonar counter was not operational during the 1980 early run migration.

Sonar counts, Russian River escapements and time of travel between sonar counter and Russian River weir for late run Russian River fish are presented in Table 11. This table indicates that elapsed time between sonar site and weir from 1968-1979 ranged from 10 to 34 days, averaging 15.1. Eliminating the 1969 and 1974 extremes of 34 and 23 days decreases this range to be between 10 and 13 days. This indicates the late run migra-

Table 10. Migrational Timing of the Late Run Russian River Sockeye Salmon Jack Escapement Compared to the Migrational Timing of the Adult Escapement, 1970-1980*.

Year	Jack Escapement	Date 50% Passed Weir	Adult Escapement**	Date 50% Passed Weir	Timing Differential (Days)
1970	2,542	8/10	25,658	8/ 7	4
1972	160	8/10	78,677	8/ 4	7
1973	332	8/ 6	24,642	7/31	7
1974	1,008	8/12	23,639	8/ 6	7
1975	1,788	8/16	30,179	8/ 5	12
1976	1,204	8/18	30,746	8/ 2	16
1978	2,874	8/18	31,356	8/ 2	16
1979	1,476	8/15	87,920	7/29	17
1980	1,533	8/19	82,450	7/30	20
1970-79 Mean	1,423	8/13	41,602	8/ 3	11

* 1971 and 1977 data have been deleted due to atypical migrational timing resulting from a velocity barrier at Russian River Falls.

** Escapement past the weir only. Fish spawning below the Falls are not included.

Table 11. Kenai River Sonar Counts Compared to Russian River Late Run Sockeye Salmon Escapements and Period of Travel Between Sonar Site and Russian River Weir, 1968-1980*.

Year	Sonar Count	Date 50% Passed	Russian River Escapement**	Date 50% Passed	Sonar to Weir (days)
1968	88,000	7/19	48,800	7/30	11
1969	53,000	6/30	28,920	8/ 2	34
1970	68,000	7/25	28,200	8/ 6	13
1972	335,000	7/24	79,000	8/ 4	12
1973	368,000	7/22	24,970	7/31	10
1974	157,000	7/17	24,650	8/ 6	23
1975	143,000	7/24	31,970	8/ 5	13
1976	381,000	7/20	31,950	8/ 2	13
1978	399,000	7/18	34,230	7/30	12
1979	322,000	7/19	87,920	7/29	10
1980	464,000***	7/19	83,980	7/30	11
1968-79 Mean	231,400	7/19	42,061	8/ 2	15.1

* 1971 and 1977 data deleted due to high water which resulted in atypical migrational timing.

** Escapement past weir only.

*** Preliminary data.

tional rate is between 7.2 (4.4 mi) and 8.5 km (5.3 mi) miles per day. It required 11 days for late run sockeye salmon to travel from sonar site to weir in 1980. Late run fish therefore migrate through the mainstem Kenai River to Russian River at more than twice the speed of early run fish. Reason(s) for these differing migrational rates are not known.

A comparison of sonar data and total Russian River late run return (harvest + escapement) provides an estimate of Russian River's contribution to the Kenai River sockeye salmon escapement. Table 12 indicates this contribution ranges from 8.7 to 66.9%, averaging 31.0%. In 1980 Russian River contributed 26.0% to the late run Kenai River sockeye salmon escapement.

Age Class Composition

Scale analysis revealed 6, 5 and 4-year fish comprised 81.4, 12.4 and 6.2% of the 1980 early run escapement, respectively. The run was dominated (84.3%) by salmon which resided 2 years in Upper Russian Lake. Age class 2.3 was the prevalent age class comprising 81.0% of the escapement. The majority of the early run were progeny of the 1974 escapement.

Early run salmon averaged 591.5 mm (23.3 in) in length. Mean lengths of 2 and 3-ocean fish were 543.5 mm (21.4 in) and 597.1 mm (23.5 in), respectively. Male to female sex ratio was 1:0.9. Early run age class composition, mean length and sex ratio approximate historical data.

Late run stocks were also dominated by salmon which resided 2 years in freshwater (67.4%). The majority of the run (81.8%) spent 2 years in salt water prior to returning to their natal stream. Male to female sex ratio (excluding jacks) was 1:1.1. Late run sockeye salmon averaged 562.7 mm (22.1 in) in length, 28.8 mm (1.1 in) less than the average early run fish. This length differential is attributable to the age structure of the respective runs. Most early run fish remain in the marine environment 3 years, as opposed to 2 years for the majority of late run fish.

Two and 3-ocean adult late run fish averaged 554.2 mm (21.8 in) and 600.9 mm (23.7 in), respectively. Two and 3-ocean late run fish are somewhat larger than early run fish of the same age class as the late run remains in the marine environment approximately 1 month longer than early run fish during their final year of life.

Age class composition of early and late runs and mean lengths for respective age classes are presented in Table 13. Table 14 summarizes early and late run Russian River sockeye salmon age class data. The dominance of Age class 2.3 in the early and 2.2 in the late run is clearly shown. The exception to the dominance of Age class 2.3 in the early run occurred in 1977. The significance of this departure from the historic age structure has been discussed (Nelson, 1978). In 1980, 25.2% of the late run was composed of Age class 1.2. This is the greatest contribution of this age class since scale analysis was begun in 1970. Reason(s) why a relatively high percentage of late run fish migrated to the marine environment after residing 1 year in Upper Russian Lake rather than the traditional 2 years is not known.

Table 12. Kenai River Sonar Counts, Total Late Russian River Sockeye Salmon Run and Percent of Kenai River Escapement to Enter Russian River, 1968-1980*.

Year	Sockeye Salmon Sonar Count	Total Late Russian River Run**	Percent Kenai River Run to Russian River
1968	88,000	58,900	66.9
1969	53,000	31,170	58.8
1970	68,000	31,000	45.6
1972	335,000	101,050	30.2
1973	368,000	40,590	11.0
1974	157,000	35,360	22.5
1975	143,000	41,050	28.7
1976	381,000	49,120	12.9
1977	757,000	65,940	8.7
1978	399,000	77,090	19.3
1979	322,000	118,670	36.9
1980	464,000***	120,690	26.0
1968-79 Mean	279,182	59,085	31.0

* 1971 data deleted due to sonar malfunction.

** Includes escapement past weir, fish spawning below Falls and sport harvest.

*** Preliminary data.

Table 13. Age Class Composition, Sample Size, Parent Year and Mean Length of Adult Sockeye Salmon in Respective Age Classes for Early and Late Run Russian River Escapements, 1980.

Age Class	Estimated No. In Escapement	Sample Size	Estimated Percent of Escapement	Parent Year	Mean Length (mm)*	S.D.**
			Early Run			
1.2	1,777	16	6.2	1976	532.5	19.0
1.3	2,322	21	8.1	1975	592.1	17.7
1.4	115	1	0.4	1974	590.0	...
2.2	1,233	11	4.3	1975	559.5	17.8
2.3	23,223	209	81.0	1974	597.6	18.0
Combined	28,670	258	100.0		591.5****	24.7****
			Late Run			
1.2	20,777	61	25.2	1976	550.7	24.5
2.2	46,667	137	56.6	1975	555.8	25.1
1.3	6,101	18	7.4	1975	602.8	20.3
2.3	8,905	26	10.8	1974	599.6	21.9
Combined	82,450***	242	100.0		562.7****	30.3****

* Length is from mid-eye to fork of tail.

** Standard Deviation.

*** Excludes 1,533 jacks.

**** Mean length and standard deviation calculated from the total sample.

Table 14. Age Class Composition by Percent of Early and Late Run Adult Russian River Sockeye Salmon Escapements, 1970-1980.

Year	Age Class 1.2	1.3	1.4	2.2	2.3	2.4	3.2	3.3
				Early Run				
1970	0.4			8.9	87.1	3.6		
1971	1.1	3.2		6.4	89.3			
1972	3.0	38.0		8.4	50.0	0.6		
1973			NO DATA AVAILABLE					
1974	0.5	32.0		3.4	63.6	0.5		
1975	0.4	1.8	0.4	19.7	75.1	0.4	0.9	1.3
1976	16.8	1.5		11.4	61.1		0.8	8.4
1977	1.9	60.7		14.0	23.4			
1978	0.1	3.0		1.6	95.3			
1979		4.5		20.9	74.6			
1980	6.2	8.1	0.4	4.3	81.0	—	—	—
1970-79 Mean*	2.7	16.1	0.0	10.5	68.8	0.6	0.2	1.1
				Late Run				
1970	2.5	2.9		87.3	7.3			
1971	1.9	5.3		61.5	30.3			
1972			NO DATA AVAILABLE					
1973			NO DATA AVAILABLE					
1974	5.5	9.0		58.6	26.9			
1975	5.4	2.9		65.9	23.9		1.9	
1976	10.9	4.3		59.6	23.6		1.0	0.6
1977	6.6	7.7		72.6	13.1			
1978	0.9	5.3		58.8	35.0			
1979	2.1	0.4		88.2	8.2		0.9	0.2
1980	25.2	7.4		56.6	10.8		—	—
1970-79 Mean**	4.5	4.7		69.1	21.1		0.5	0.1

* 1973 deleted from computations. Nine-year mean.

** 1972 and L973 deleted from computations. Seven-year mean.

Length-frequency of 258 early run sockeye salmon is presented in Figure 4. This figure indicates 79.8% of these fish exceed 580 mm (22.8 in), whereas Figure 5 reveals 71.5% of the late run was less than 580 mm (22.8 in). This length differential is again a function of the age structure of the population.

Early Run Return Per Spawning Fish

Table 15 presents the numbers of fish produced for each early run fish in the parent (brood) year spawning escapement. From 1963-1974 the return per spawning fish in the parent year escapement averaged 2.6, ranging from 0.2-10.6. The significance of a return of 10.6 fish for each salmon in the escapement has been discussed (Nelson, 1979). The author also noted a large spawning escapement does not necessarily ensure a high return rate. The lowest return per spawner (0.2) was produced by one of the largest parent year escapements (21,510).

Return per spawner for the 1974 parent year which returned in 1978, 1979 and 1980 was 4.0. This is one of the highest return rates recorded for early run sockeye salmon.

Forester (1968) indicates that irrespective of the level of escapement, the fluctuations in the numbers of returning adult fish are quite marked. The Fraser River return per spawner from 1938 to 1954 ranged from 2.2-13.0, averaging 5.4. Forester concludes that most of the variability in production is attributable to environmental conditions during the fresh water developmental stages. Available data suggests early run Russian River sockeye salmon production may be related to stream flow conditions at Upper Russian Creek during egg incubation.

Fecundity Investigations

Fecundity investigations initiated in 1973 were continued during the 1980 season. Results are presented in Table 16.

Fecundity of early run salmon ranged from 2,573 to 4,497 eggs per female with a mean of 3,534.3. Mean weight and length of females sampled was 2.41 kg (538 lb) and 572.9 mm (22.5 in), respectively. These fish averaged 1,461 eggs/kg of body weight and 6.2 eggs/mm of body length. Late run sockeye salmon averaged 2,739.7 eggs/female with a range of 2,020-3,659. Mean weight of late run fish sampled was 1.98 kg (4.37 lb). Mean length was 543.7 mm (21.4 in). These fish averaged 1,382 eggs/kg of weight and 5.0 eggs/mm of length. Table 17 compares these data with results from prior investigations.

Table 17 indicates the average early run female in 1980 was smaller (both length and weight) than those sampled in prior years. Mean eggs per female is also the lowest recorded although eggs/kg and eggs/mm are comparable to historic data. Fish sampled during the late run show similar trends. Mean egg content, weight, egg/mm and eggs/kg were the lowest recorded. Reason(s) for the relatively small early and late run fish are not known.

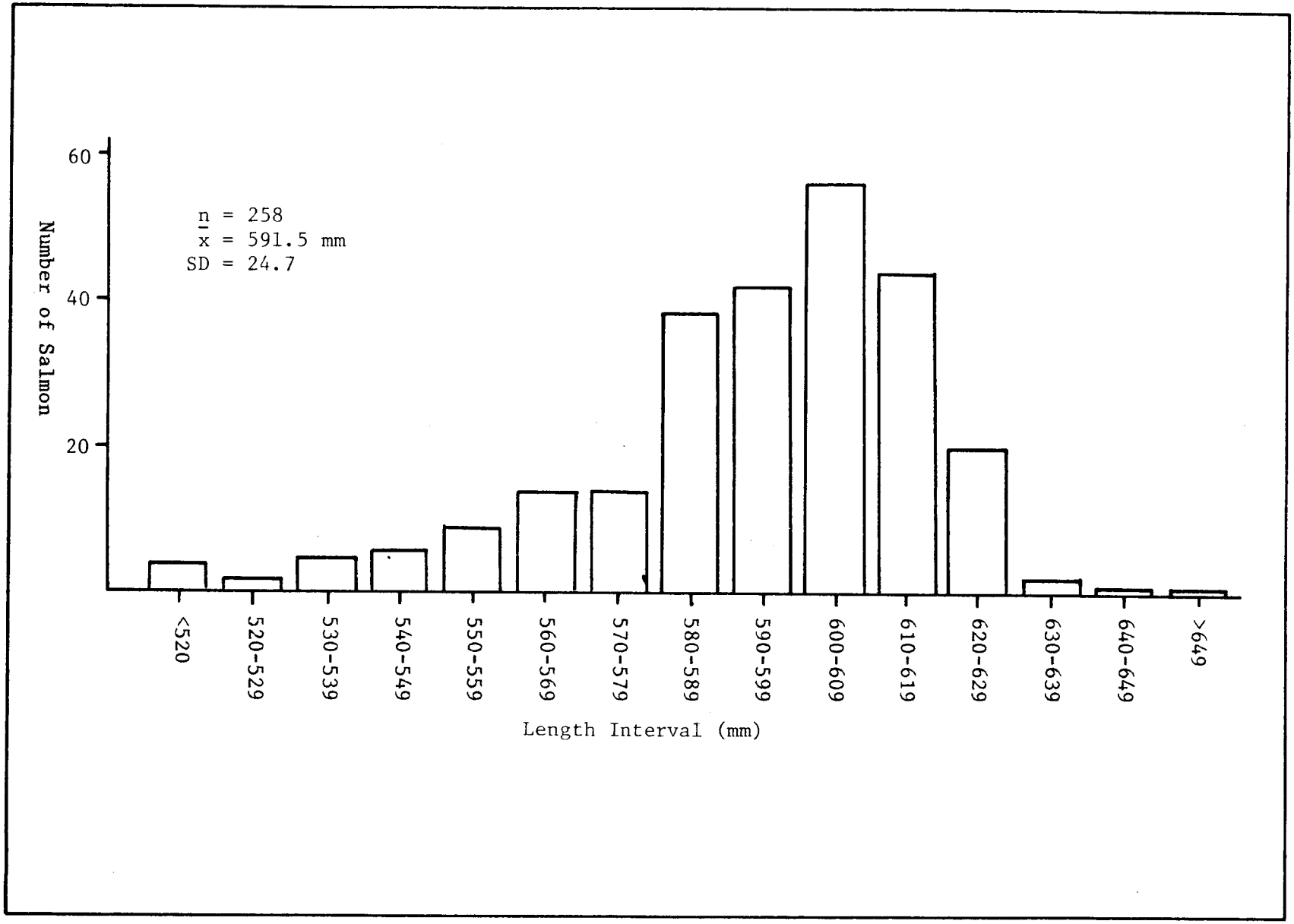

Figure 4. Length Frequency of Early Run Russian River Sockeye Salmon Sampled at Lower Russian Lake Weir, 1980.

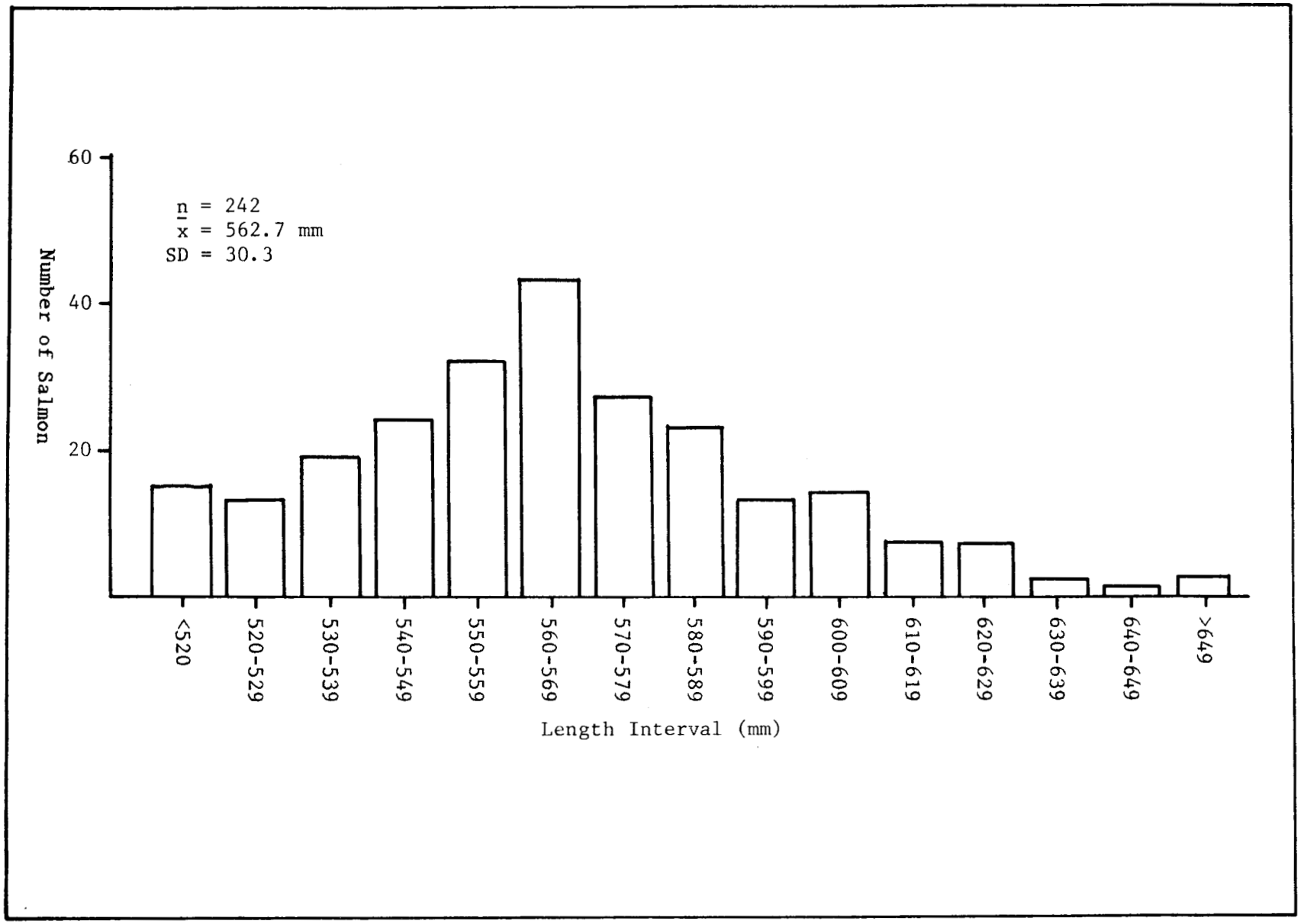

Figure 5. Length Frequency of Late Run Russian River Sockeye Salmon Sampled at Lower Russian Lake Weir, 1980.

Table 15. Estimated Production from Known Escapements of Early Run Russian River Sockeye Salmon, 1969-1980.

Parent Year	Parent Year Escapement	Total Return* (Production)	Return Per Female	Return Per Spawner
1963	14,580	10,870	1.5**	0.7
1964	12,700	11,200	1.8**	0.9
1965	21,510	4,875	0.4**	0.2
1966	16,660	8,183	1.0	0.5
1967	13,710	19,628	2.8	1.4
1968	9,200	18,946	4.0	2.0
1969	5,000	14,508	5.8	2.9
1970	5,450	12,810	5.3	2.3
1971	2,650	10,896	8.7	4.1
1972	9,270	98,775	26.6	10.6
1973	13,120	24,962	3.8	1.9
1974	13,150	52,704	9.7	4.0
Total	137,000	288,357	71.4	31.5
Mean	11,417	24,029	5.9	2.6

* Return equals sport harvest plus escapement. A negligible commercial harvest is assumed.

** Assumes a male to female sex ratio of 1:1.0. Sex ratios for succeeding years determined by sampling.

Table 16. Fecundity of Early and Late Run Russian River Sockeye Salmon as Determined by Sampling at Lower Russian Lake Weir, 1980.

Sample Number	Weight kg	Weight (lb)	Length (mm)	Number of Eggs Right Skein	Number of Eggs Left Skein	Number of Eggs Combined
			Early Run			
1	2.29	(5.06)	560	1,336	1,578	2,914
2	2.81	(6.19)	590	1,894	2,180	4,074
3	2.58	(5.69)	580	1,833	2,016	3,849
4	3.12	(6.87)	615	1,664	2,106	3,770
5	2.66	(5.87)	610	2,051	2,086	4,137
6	2.49	(5.50)	585	1,719	1,918	3,637
7	2.86	(6.31)	600	2,102	2,395	4,497
8	2.29	(5.06)	580	1,811	1,892	3,703
9	1.93	(4.25)	540	1,205	1,368	2,573
10	2.15	(4.75)	545	1,179	1,479	2,658
11	1.59	(3.50)	510	1,315	1,464	2,779
12	2.21	(4.87)	560	1,906	1,915	3,821
Mean	2.41	(5.33)	572.9	1,667.9	1,866.4	3,534.3
			Late Run			
1	2.21	(4.87)	560	1,210	1,358	2,568
2	2.61	(5.75)	565	1,568	1,985	3,553
3	2.55	(5.63)	575	1,341	1,400	2,741
4	2.35	(5.19)	565	1,739	1,920	3,659
5	2.15	(4.75)	565	1,445	1,580	3,025
6	1.70	(3.75)	530	1,284	1,226	2,510
7	1.73	(3.81)	520	1,463	1,099	2,562
8	1.93	(4.25)	550	1,502	1,596	3,098
9	1.81	(4.00)	540	1,011	1,034	2,045
10	1.42	(3.13)	490	982	1,190	2,172
11	1.79	(3.94)	550	1,245	1,678	2,923
12	1.55	(3.43)	515	1,016	1,004	2,020
Mean	1.98	(4.37)	543.7	1,317.2	1,422.5	2,739.7

Table 17. A Comparison of Fecundity Data Collected at Lower Russian Lake Weir During Early and Late Run Russian River Sockeye Salmon Migrations, 1973-1980.

Year	Mean Fecundity	Mean Length(mm)	Mean Weight(kg)	Eggs/ Kilogram	Eggs/ Millimeter
			Early Run		
1973	4,630	627.0	2.968	1,560	7.4
1974	3,569	603.0	2.603	1,371	5.9
1975	3,952	600.0	2.540	1,556	6.6
1976	3,668	596.0	2.608	1,406	6.1
1977	4,313	602.7	2.852	1,512	7.1
1978	3,815	608.1	2.821	1,342	6.3
1979	3,842	577.0	2.490	1,543	6.7
1980	3,534	572.9	2.418	1,461	6.2
			Late Run		
1973	3,190	569.0	2.187	1,459	5.6
1974	3,261	558.0	2.301	1,417	5.8
1975	3,555	555.0	2.257	1,575	6.4
1976	3,491	587.0	2.533	1,378	5.9
1977	3,302	567.1	2.438	1,354	5.8
1978	2,865	584.0	2.672	1,072	4.9
1979	3,314	542.0	2.204	1,504	6.1
1980	2,740	543.7	1.982	1,382	5.0

Russian River Falls Fish Pass

The Russian River Falls fish pass was constructed during the winter of 1978-1979. The structure was employed during the 1979 season but no formal evaluation was conducted at that time. Observation in 1979 indicated both early and late run fish were attracted to and did utilize the fish pass at normal water flows. An estimated 1,600 late run fish circumvented the Falls via the fish pass during a brief period of atypically high water. It was concluded that given an option at normal water levels, most early and late run fish will ascend the falls rather than utilize the fish pass. Concerns that operation of the fish pass at low or normal water levels would divert the fish through the tunnel, thus reducing the value of this historic sockeye salmon viewing area, appeared unfounded (Nelson, 1980).

Surveys by the Soil Conservation Service of the U.S. Department of Agriculture (1980) during the winter of 1978-1979 revealed the snowpack water content in areas adjacent to Russian River were three times greater than the 10-year mean. The record snowpack coupled with the annual spring rains again resulted in above-average discharge rates through Russian River Falls (Figure 6).

Figure 6 indicates that stream discharge exceeded 400 cfs during all of the early and most of the late run's migration. Nelson (1978) indicated that stream velocities in excess of 400 cfs were a total barrier to sockeye salmon migration. The extreme flow rates presented an excellent opportunity to evaluate the fish pass. Purpose of the evaluation was to determine the percentage of the escapement which utilized the structure and to determine its general effectiveness.

During the early run seventy-seven 15-minute counts were made at the exit of the fish pass. Counts ranged from one fish/15 minutes (2 fish/hour) to 37 fish/15 minutes (148 fish/hour). The mean number of fish/hour during the early run was 55. Passage rates by hour are graphically presented in Figure 7. Early morning and late evening counts were significantly lower that mid-day passage rates. Peak passage rates occurred from 1100 to 1900 hours.

The estimated number of early run sockeye salmon which utilized the fish pass from June 16 - July 2 (period counts were made) is 19,635. The actual number enumerated at Russian River weir during this period was 20,336. The minimal discrepancy between the estimated number which negotiated the fish pass and the number enumerated at the weir is attributed to the three hour period 1200-0300 hours which was not monitored. Late evening and early morning counts suggest migration during this period was minimal ($\sim$15 fish/hour). When this extrapolated estimate is added to the estimate based on observations, the correlation between fish pass and weir counts are in close agreement (20,370 versus 20,336). Observation during this period indicated no fish were migrating through the falls. It is concluded that 100% of the 1980 early run escapement negotiated the Falls via the fish pass.

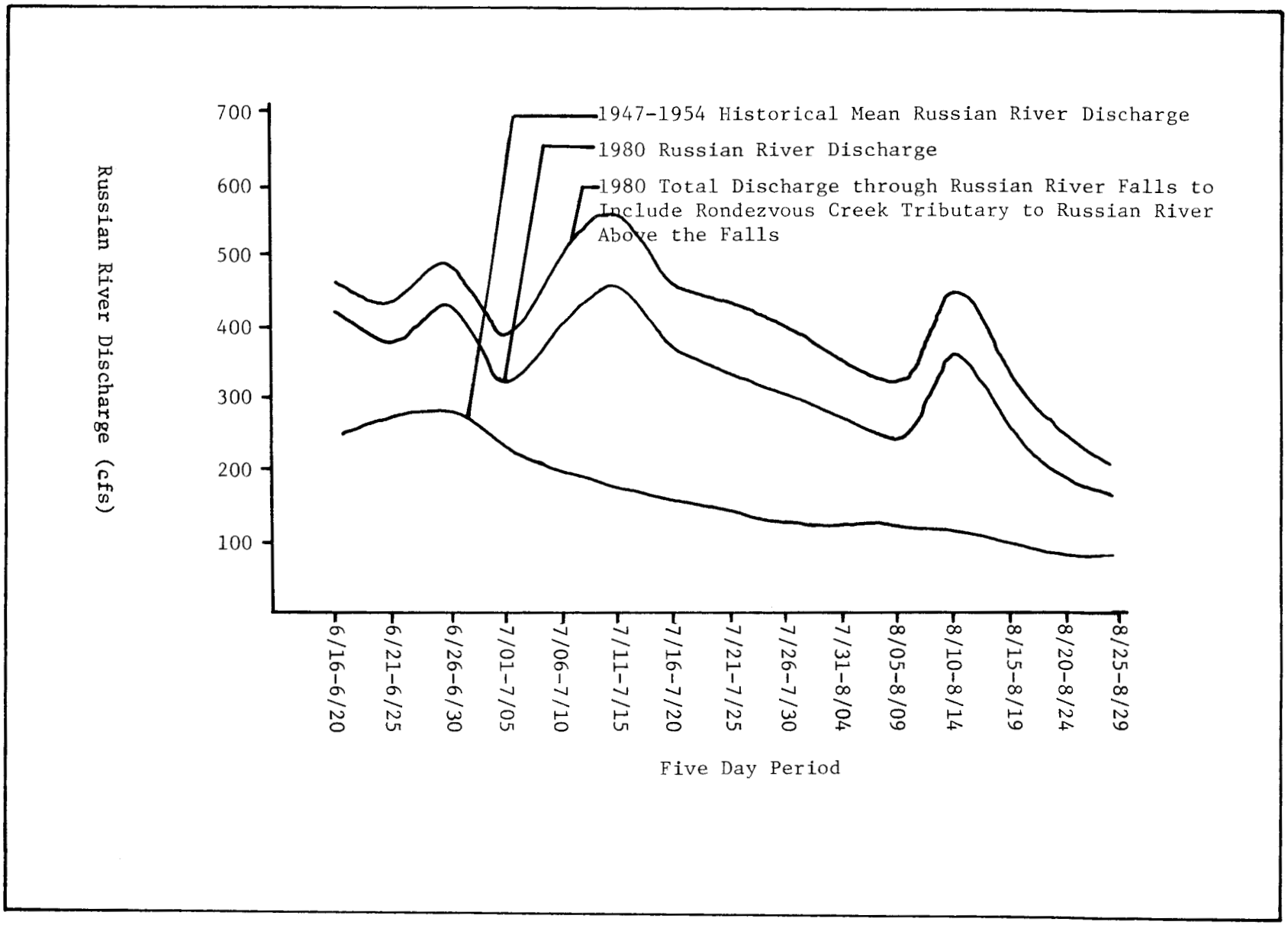

Figure 6. Mean (eight year) Russian River Discharge Rates by Five Day Mean Recorded by United States Geological Survey from 1947 through 1954 Compared to 1980 Discharge Rates.

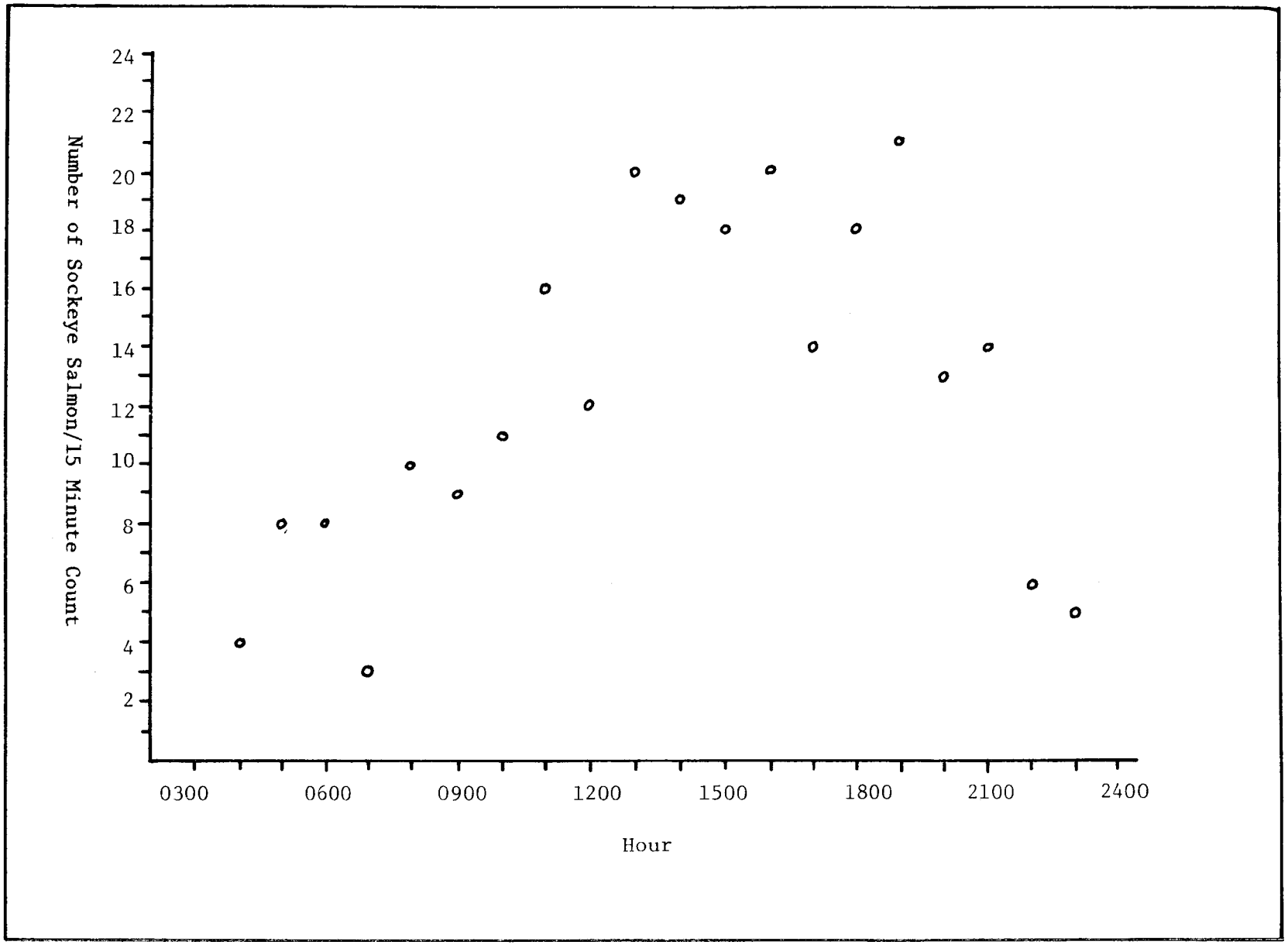

Figure 7. Mean Early Run Russian River Fish Pass Counts by Hourly Period, 1980.

Evaluation during the late run occurred during the peak of this stock's migration (July 23-29). The mean passage rate was 510 fish/hour which was 3.4 times the mean passage rate of early run fish. Passage rates are undoubtedly related to numbers of fish present below the Falls as the total late run escapement was 2.9 times as great as the early run. Water velocity prior to August 5 remained above 400 cfs and observation did not detect any late run fish successfully negotiating the Falls. Late run escapement prior to August 5 was 59,671 fish and it is assumed these fish circumvented the Falls via the fish pass.

After August 5, flow rates decreased and the late run could ascend the Falls either by their historical migratory route or via the fish pass. It is estimated that approximately 50% of the fish which negotiated the Falls after August 5 did so via the fish pass. The total estimate of late run sockeye salmon utilizing the fish pass was therefore 71,828 or 85.5% of the late run escapement which spawned above Russian River Falls.

High water in 1971 and 1977 delayed both early and late run migrations despite attempts by the Department of Fish and Game to manually transport fish around the barrier. Mortality below Russian River Falls was documented as a result of these delays (Nelson, 1978). Operation of the fish pass during high water periods in 1980 precluded the disruptional influence of high water on the migrational rate of these stocks. No mortality occurred below Russian River Falls in 1980 and observation at the weir revealed virtually all fish were in excellent physical condition. The fish pass therefore functioned as designed and has the capability to permit sockeye salmon unrestricted passage to the spawning grounds during periods of high water.

Figures 8 and 9 depict the migrational rate of early and late run fish in 1980 compared to historical migrational rates. These figures reveal that, despite high stream flow, the migrational rate in 1980 was more rapid than during years of normal flows when the fish pass was not present. This not only suggests the fish pass transported sockeye salmon with a high degree of efficiency, but that its operation or non-operation in future years may be used to regulate fish passage rates. Slow passage rates during years of high return would maximize harvest rates, while accelerated passage during years of low returns would decrease harvest and increase escapement. Management options associated with operation or non-operation of the fish pass should be explored in future years.

Egg Deposition

Assuming the mean fecundity of early run fish sampled is representative of early run stocks, the potential number of eggs available for deposition in Upper Russian Creek may be calculated. Losses between weir and spawning grounds, females which perish without spawning and mean numbers of eggs retained per spent female must be considered. Nelson (1976) has presented a detailed discussion of these criteria and the methodology employed to calculate potential early run egg deposition. Potential early run egg depositions since 1973 are presented in Table 18.

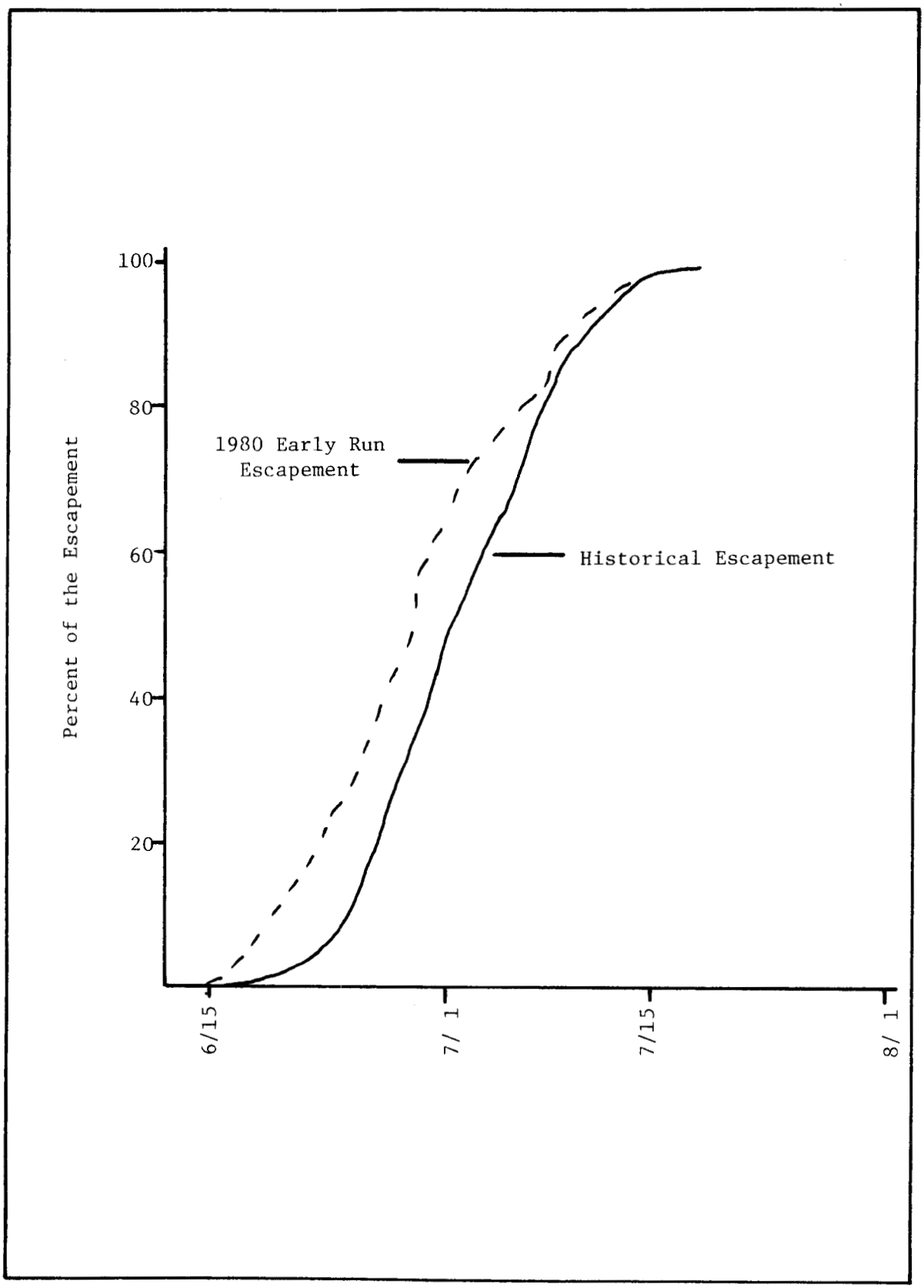

Figure 8. Migrational Timing of the 1980 Early Run Russian River Sockeye Salmon Run Based on Weir Escapements Compared to Historical Escapement Rates.

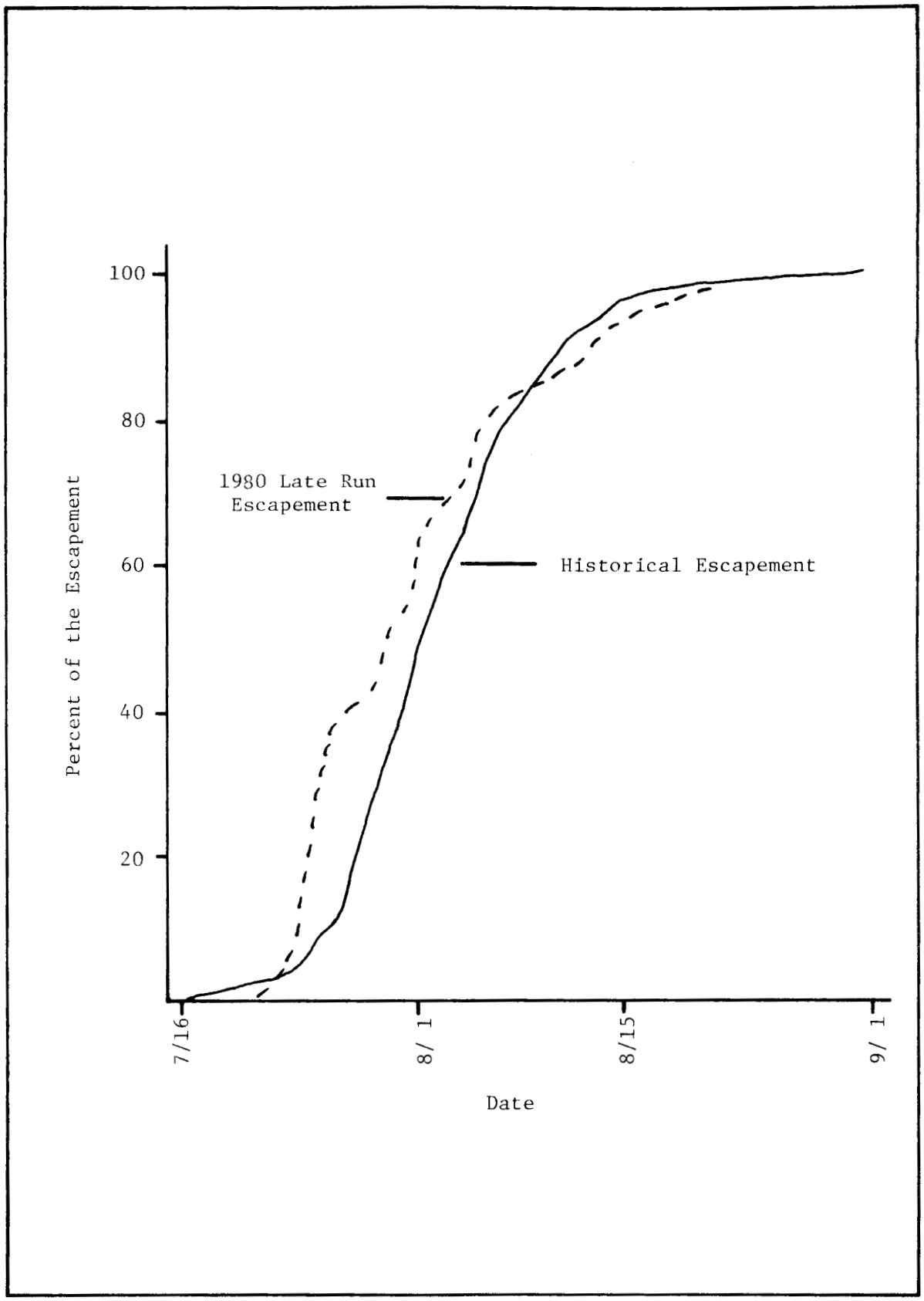

Figure 9. Migrational Timing of the 1980 Late Run Russian River Sockeye Salmon Run Based on Weir Escapement Compared to Historic Escapement Rates.

Table 18. Potential Egg Deposition From Known Early Run Sockeye Salmon Escapements in Upper Russian Creek and Known Returns Produced by these Escapements, 1972-1980.

Year	Escapement	Potential Egg Deposition (millions)	Adult Return
1972	9,270	15.0	98,773
1973	13,120	29.6	24,962
1974	13,150	17.7	30,547
1975	5,640	12.7	
1976	14,700	23.5	
1977	16,070	18.2	
1978	34,150	62.8	
1979	19,700	30.9	
1980	28,670	44.2	

Potential egg deposition in 1980 is estimated at 44.2 million which is the second largest number of eggs available for deposition since 1973. Inspection of data in Table 18 reveals that the greater the spawning escapement, the greater the potential egg deposition. However, variability in reproductive potential does occur irrespective of the actual numbers of spawners in that the mean fecundity and male to female sex ratio are subject to annual variation (Hartman and Conkle, 1960). It should also be noted that a definitive relationship is not evident between numbers in the spawning escapement, potential eggs available for deposition and adult return.

Egg sampling to determine actual egg deposition and survival of early run eggs in Upper Russian Creek was conducted September 30-October 1. Sampling was conducted in the upper nine sections of the stream. Sections "0" and "I" could not be sampled due to high water. Numbers of eggs dug per sampling point ranged from 0 to 619, averaging 58.0 Mean egg density was estimated at 315.5 eggs/M^2. Egg survival was 68.6% at time of sampling (Table 19).

Table 19 indicates the 1980 egg density is the highest recorded since 1974. The 1975 early run escapement was one of the smallest recorded which accounts for low egg deposition that year. Nelson (1978) indicated Upper Russian Creek may have been subject to extreme high water in 1976 and 1977 which washed eggs from the gravel resulting in low deposition estimates. The same author (Nelson, 1979) indicated moderate water flows occurred during the 1978 incubation period. Egg sampling in 1979 was not conducted due to high water and it is assumed an unknown percentage of the eggs were washed from the gravel. Observation in 1980 indicates flood conditions occurred after egg sampling was conducted. Density estimates for 1980 may therefore not reflect the number of eggs which incubate during the winter of 1980-81.

As noted earlier in this report, high numbers of early run spawners do not necessarily produce large returns. Egg density data to date suggest a more consistent relationship between numbers of eggs in the gravel of Upper Russian Creek and return rate. High egg densities were recorded in 1972 and 1973. The return rates in 1978 and 1979 were similarly high. On the basis of these data, Nelson (1980) suggested the adult return in 1980 would be above average, as egg density in 1974 was the highest recorded. This observation proved correct. Should the relationship of eggs in the gravel to adult return continue, the adult return from 1981-1983 will be below average.

The above data therefore suggest that environmental conditions in Upper Russian Creek during the spawning and incubation period exert a greater influence on numbers of returning adults than do actual numbers of early run fish in the parent year escapement. It is the recommendation of the author that serious consideration be given to investigating methods whereby the stream flow in Upper Russian Creek could be stabilized during the critical spawning and incubation period.

Table 19. Early Run Russian River Sockeye Salmon Egg Densities in Upper Russian Creek and Known Adult Returns from these Densities, 1972-1980.

Year	Total Eggs Dug	Mean Eggs Per Point	Percent Survival	Density (Egg/M2)	Adult Return
1972	3,790	75.8	81.1	407.8	98,773
1973	2,967	59.3	93.0	319.6	24,962
1974	8,229	84.0	64.2	455.6	30,547
1975	605	6.2	84.3	33.3	
1976	901	12.7	91.6	61.3	
1977	981	12.6	55.0	67.7	
1978	4,415	48.0	87.6	226.1	
1979		NO SAMPLE - HIGH WATER			
1980	5,102	58.0	68.6	315.5	

Table 20. Climatological and Hydrological Observations by Six-Day Periods Recorded at Lower Russian Lake Weir, June 13 - September 4, 1980.

Period	Water Temperature* Max°C	Water Temperature* Min°C	Air Temperature* Max°C	Air Temperature* Min°C	Rainfall (mm)**	Russian River Discharge(cfs)	Rondezvous Creek Discharge(cfs)
June 13-18	8.7	6.4	14.1	9.4	11.2	390.0	47.5
June 19-24	8.6	6.9	13.6	4.0	8.5	401.7	43.3
June 25-30	8.8	7.4	13.5	7.0	17.6	406.7	61.6
July 1-6	10.1	8.1	15.7	5.9	6.0	313.3	61.7
July 7-12	10.0	8.9	13.9	7.4	29.3	388.3	93.3
July 13-18	10.9	9.3	15.9	5.5	1.4	460.0	101.7
July 19-24	13.8	10.1	21.7	5.7	33.0	341.6	96.7
July 25-30	12.9	11.1	16.6	7.8	27.0	313.3	95.0
July 31-August 5	12.6	10.9	16.0	5.5	8.5	278.3	81.7
August 6-11	12.7	11.3	15.2	8.2	27.9	281.7	76.7
August 12-17	11.7	10.4	13.1	5.0	32.4	320.0	83.3
August 18-23	10.9	9.1	12.8	2.7	11.1	216.7	63.3
August 24-29	11.0	9.4	14.6	2.6	3.2	168.3	46.6
August 30 - September 4	9.9	8.2	11.3	0.4	7.9	145.0	35.0

* Air and water temperatures for the respective periods are the mean of the daily recordings.

** Rainfall for each period is the cumulative total of the daily recordings.

Climatological Observations

Climatological data recorded at Lower Russian Lake were grouped by 6-day periods to facilitate analysis (Table 20). No correlation was found between air and water temperature and sockeye salmon migration. Air and water temperatures during the 1980 season are comparable to prior years' data. Total precipitation recorded was 325 mm (12.8 in). This precipitation undoubtedly contributed to high Russian River discharge rates. The effect of high Russian River flows on the early and late run migration has been discussed earlier in this report.

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